

CLAIMS

What is claimed is:

1. A method of improving backup performance of block storage over a network with asymmetric traffic, comprising:

a client concurrently sending a write command and associated data to a server;

the server executing the write command, and suppressing a SCSI Ready to Transfer (RTT) message, if any is scheduled to be issued by the server;

the server combining a protocol acknowledgment message with a SCSI acknowledgment message, into an acknowledgment message, and transmitting the combined acknowledgment message to the client; and

upon receipt of the combined acknowledgment message, the client recognizing a successful execution of the write command by the server and de-allocating a buffer that contains the associated data.

2. The method of claim 1, wherein the server further selectively delays an issuance of the protocol acknowledgment message from the server to the client.

3. The method of claim 2, wherein the protocol acknowledgment message is a TCP/IP acknowledgment message.

4. The method of claim 3, wherein the combined acknowledgment message is a combined SCSI /TCP/IP acknowledgment message.

5. The method of claim 2, wherein the client sends a sequence of asynchronous write commands to the server.

6. The method of claim 5, wherein the server delays the issuance of a combined SCSI /TCP/IP acknowledgment message for each of the write commands.

7. The method of claim 6, wherein the server further merges combined SCSI /TCP/IP acknowledgment messages for at least some of the write commands into a batch SCSI /TCP/IP acknowledgment message.

8. The method of claim 7, wherein the server sends the batch SCSI /TCP/IP acknowledgment message to the client.

9. The method of claim 8, wherein in response to the batch SCSI /TCP/IP acknowledgment message, the client de-allocates buffers associated with the at least some of the write commands.

10. The method of claim 2, wherein the server transmits the combined acknowledgment message to the client before an expiration of a predefined acknowledgment constraint window.

11. The method of claim 10, wherein the predefined acknowledgment constraint window is approximately 500 msec.

12. The method of claim 2, further including the step of instructing the client to delay resending the write command and associated data to the server.

13. The method of claim 12, wherein the instructing step comprises adding a predetermined delay interval to a round trip time.

14. The method of claim 13, wherein adding the predetermined delay interval comprises adding approximately 500 msec to the round trip time.

15. The method of claim 1, wherein, upon detecting congestion, the server does not delay the issuance of the protocol acknowledgment message to the client.

16. The method of claim 15, wherein the server detects congestion by receiving a notification from the client.

17. The method of claim 16, wherein the notification from the client comprises a message indicating a rate at which client buffers are getting full.

18. The method of claim 1, wherein the network comprises a wide area network.

19. The method of claim 1, wherein the network comprises a local area network.

20. A method of improving backup performance of block storage over a network with asymmetric traffic, comprising:

- a client concurrently sending a write command to a server;
- the server executing the write command, and dynamically controlling a SCSI Ready to Transfer (RTT) message, if any is scheduled to be issued by the server;
- the server combining a protocol acknowledgment message with a SCSI acknowledgment message, into an acknowledgment message, and transmitting the combined acknowledgment message to the client;
- and
- upon receipt of the combined acknowledgment message, the client sending data associated with the write command to the server.

21. The method of claim 20, wherein upon recognizing a successful execution of the write command by the server, the client de-allocates a buffer that contains the data.

22. The method of claim 21, wherein the server monitors a buffer consumption; and

if the buffer consumption exceeds a predetermined level, the server sends a message to the client instructing the client to delay sending the data to the server.

23. The method of claim 22, further instructing the client to await a RTT message prior to sending the data to the server.

24. The method of claim 22, wherein the predetermined level is approximately 90% of a total server buffer capacity.

25. The method of claim 23, wherein if the buffer consumption is below the predetermined level, the server sends a message to the client instructing the client to not delay sending the data to the server.

26. The method of claim 21, wherein the server further selectively delays an issuance of the protocol acknowledgment message from the server to the client.